# Failure Analysis of Investment Cast Gas Turbine Blades at High Temperature Conditions

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## ABSTRACT

Turbine blade is the most important component of the gas turbine. The excellent thermal stability, tensile and fatigue strengths, resistance to creep and hot corrosion, and micro-structural stability possessed by nickel-based super alloy render the material an optimum choice for application in turbine blades. Hot corrosion is an accelerated damage phenomenon that occurs when high temperature turbine blades made of super alloys are operated in an environment containing salt and sulfur. This project work presents the failure analysis of turbine blades used for gas turbine in marine applications. The turbine blade was made of Nickel based super alloys and was fabricated by investment casting method. The turbine blade was operated at elevated temperatures in corrosive environmental attack such as oxidation, hot corrosion and sulphidation. The gas turbine blade was operated for about 10000 hours. Hot corrosion on turbine blades can be intensified by the presence of vanadium, which produces $V_20_5$, in combination with the alkalis, while in molten state, can aggressively dissolve metal oxides.

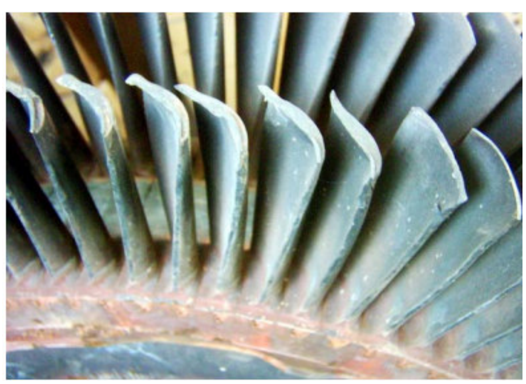

Figure 1: Blades operated at high temperature.

The turbine blade was operated at elevated temperatures from $900^{o}$ to $950^{o}$C for about 10000 hours. There were a large number of cracks at different regions of blades because of operation at high temperatures and stresses over a long period of time as shown in figure 1. There was loss of some material and thickness as well, at the tip of the turbine blade which is attributed to the combined mechanisms such as hot corrosion and fatigue. Very little sulphide formation within the metal was observed. Sulphidation is an important contributing factor to the failure of turbine blades especially in the turbines operating in marine environment. The microstructure at the root of the blade consisting of equiaxed grains of nickel solid solution. Fine particle of $\gamma^{l}$ precipitated within the matrix and dispersed carbide particle were found in the grain boundaries.

There were a large number of cracks at different regions of blades because of operation at high temperatures and stresses over a long period of time. Intergranular cracks are revealed on fracture surface of blades as shown in figure 2.

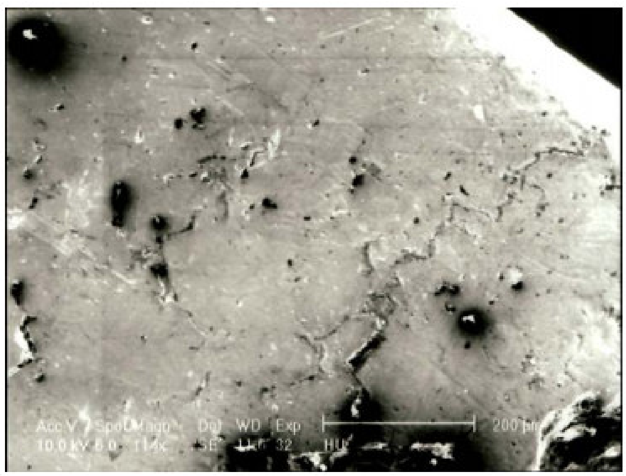

Figure 2: Intergranular Fracture Morphology.

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